Coastal Land Cover Classification Using Sentinel-1 Images

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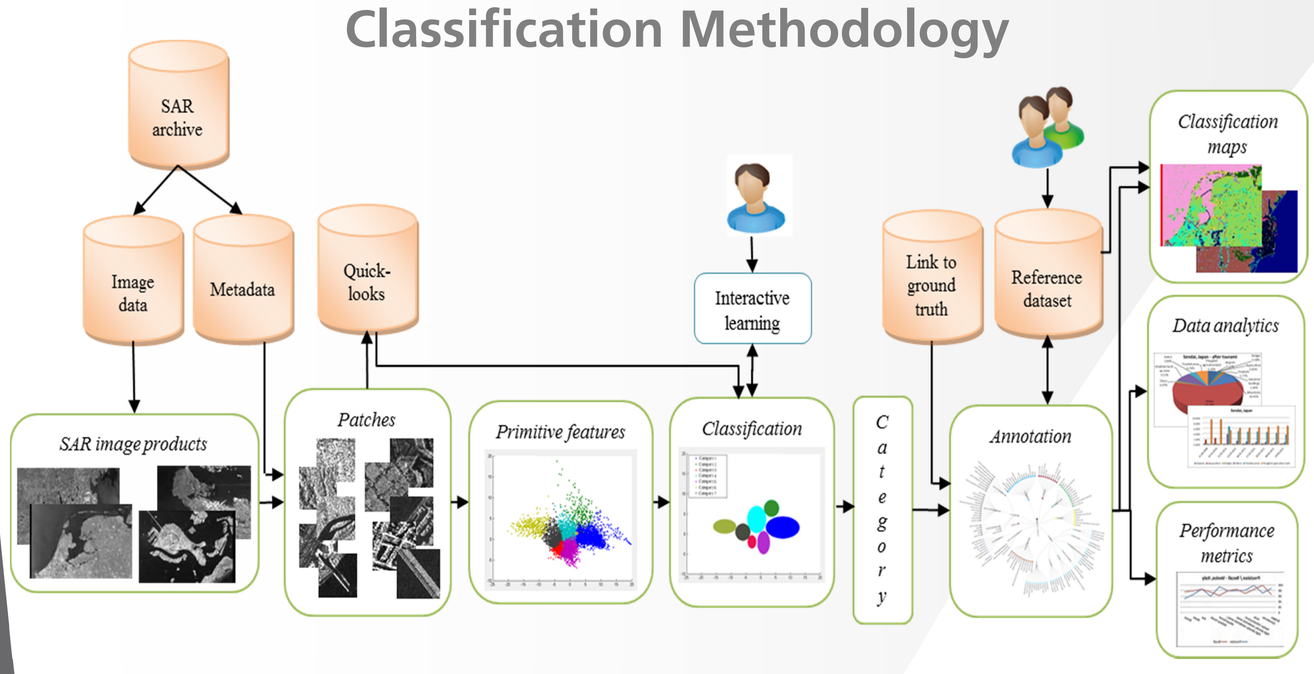
Abstract

The analysis of traditional satellite image products can be supported by Thematic Exploitation Platforms (TEPs). A TEP is *"a collaborative, virtual work environment providing access to EO data and the tools, processors, and Information and Communication Technology resources required to work with them, through one coherent interface"* [1]. During the analysis phase of a Coastal TEP [2], we investigated the classification accuracy of TEP information retrieval tools for coastal area images as recorded by medium- and high-resolution SAR instruments, namely Sentinel-1A and TerraSAR-X. It turns out that Sentinel-1A data are well suited for the classification of natural habitats, while the identification of human-made infrastructures needs higher resolution data.

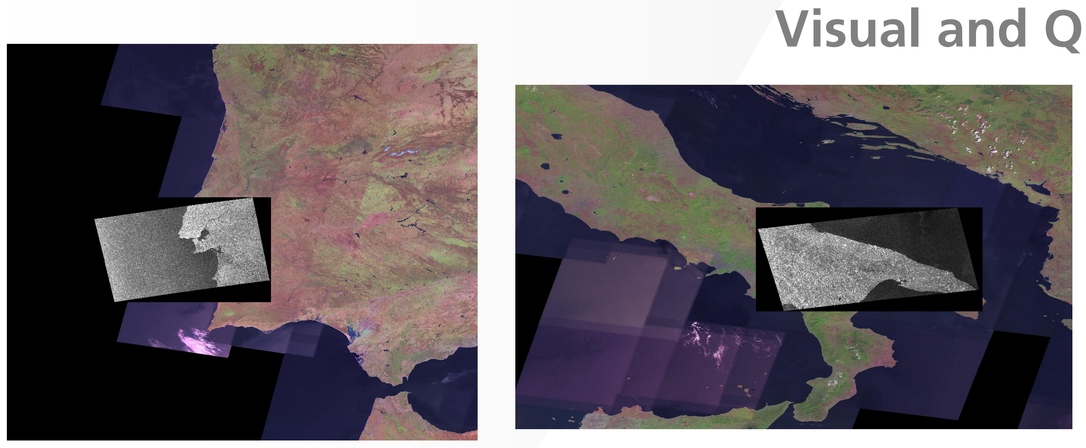
Classification Methodology



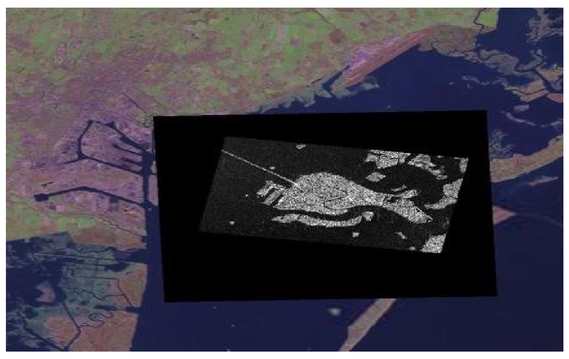
Coastal Land Cover Areas

- Coastal areas call for dedicated analysis tools as they are characterized by characteristic static and dynamic features [2].
- Coastal areas are a prime target for environmental studies.
- Coastal areas can be studied by modern data analytics tools [4].
- Image classification and semantic labelling tools can be adapted to the characteristics of coastal areas and their image products [5].
- These adapted classification tools prove to be stable and reliable.
- Sentinel-1A medium-resolution images typically yield about 5-10 image content categories [3] with a recall accuracy of about 75%.
- TerraSAR-X high-resolution images typically yield more than 5-20 image content categories [3] with a recall accuracy of about 80%.
- As a consequence, large-area land cover classification of natural surfaces can be performed efficiently with Sentinel1-A data.
- More detailed local analyses of selected target areas deserve high-resolution data, such as TerraSAR-X images.

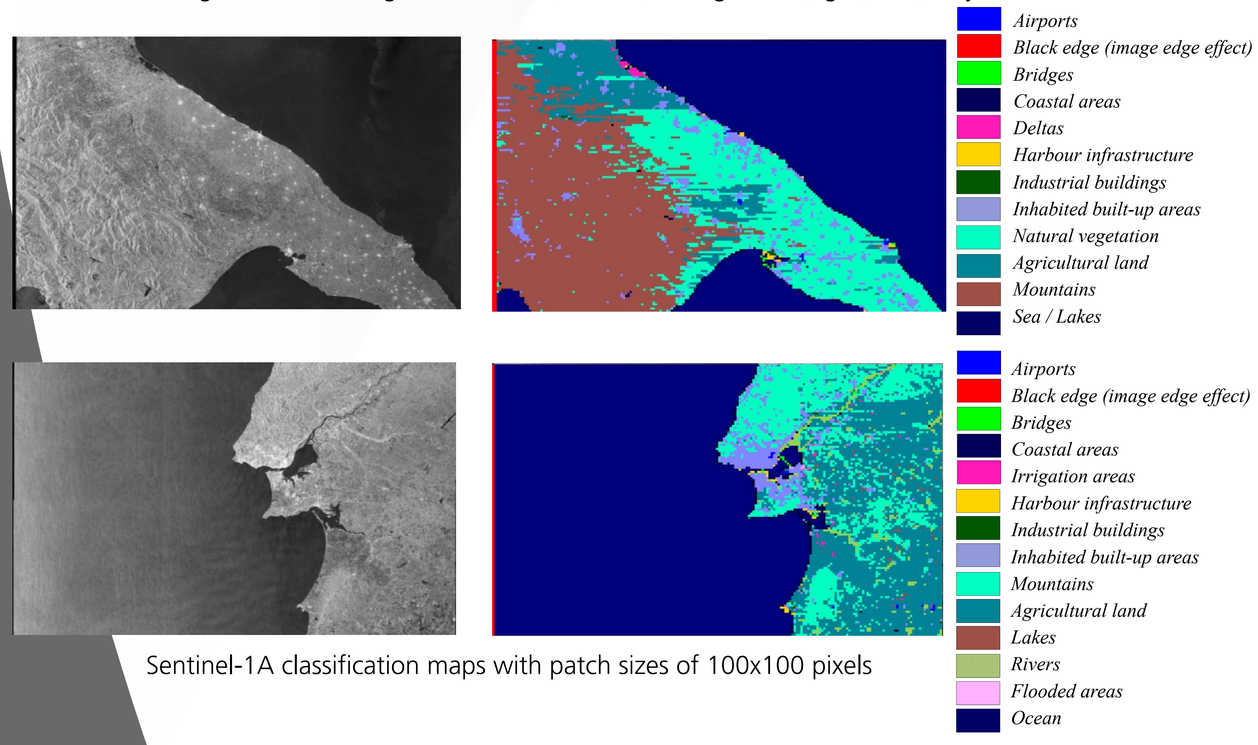
Visual and Quantitative Results



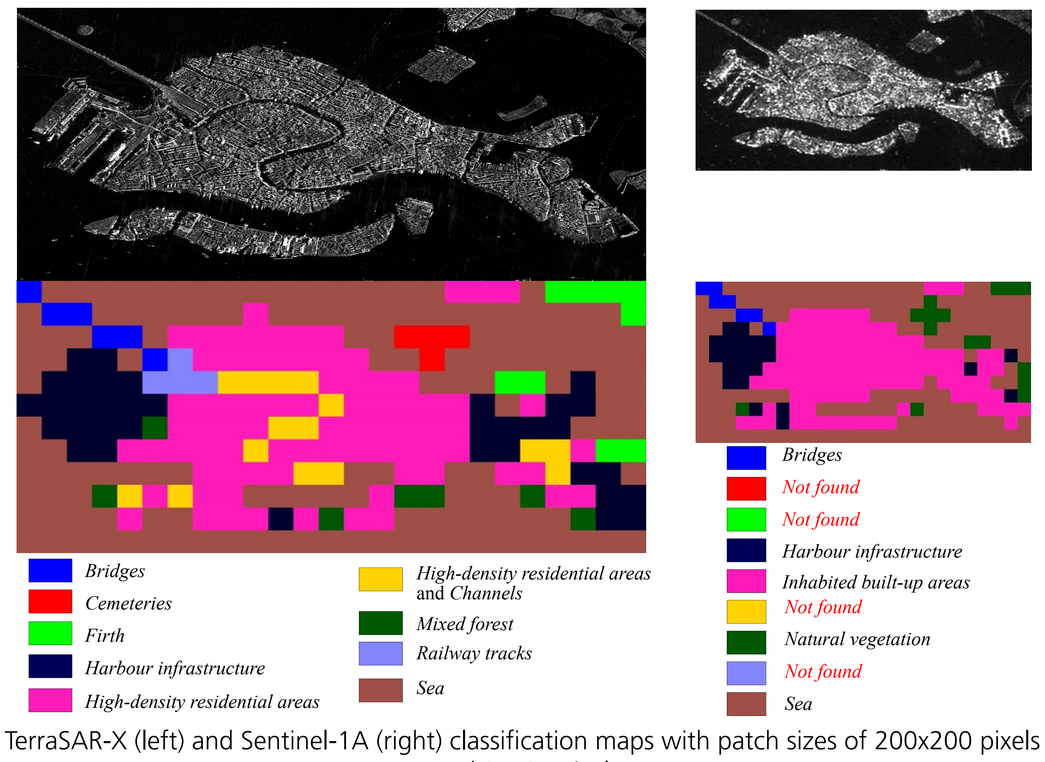
Sentinel-1A image locations using QGIS [6]: (left) Lisbon, Portugal and (right) Bari, Italy.



TerraSAR-X and Sentinel-1A image locations using QGIS [6] Venice, Italy.



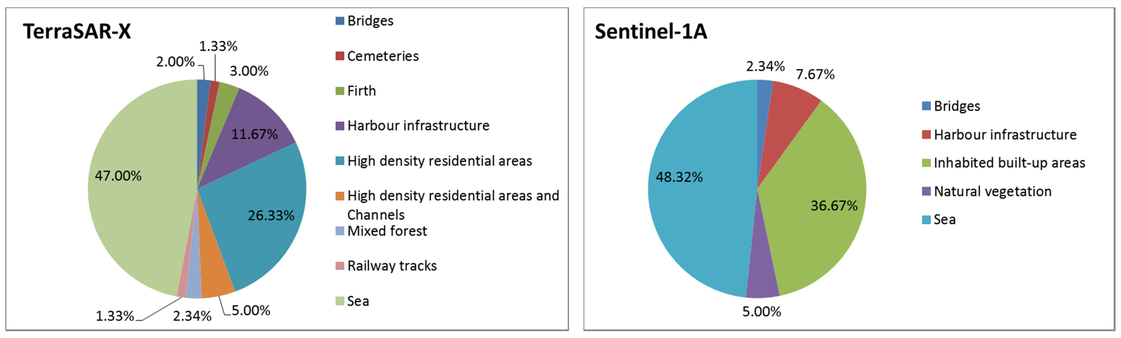
Sentinel-1A classification maps with patch sizes of 100x100 pixels



TerraSAR-X (left) and Sentinel-1A (right) classification maps with patch sizes of 200x200 pixels and 25x25 pixels

Semantic annotation	TerraSAR-X patch size 200×200 pixels		Semantic annotation	Sentinel-1A patch size 25×25 pixels	
	Precision	*Recall*		*Precision*	*Recall*
Bridges	100.00	75.00	Bridges	100.00	87.50
Cemeteries	100.00	100.00	*Not found*		
Firth	100.00	90.00	*Not found*		
Harbour infrastructure	74.28	83.87	Harbour infrastructure	78.26	56.25
High-density residential areas	81.28	90.28	Inhabited built-up areas	84.55	90.29
High-density residential areas and Channels	86.67	56.52	*Not found*		
Mixed forest	85.71	54.55	Natural vegetation	66.67	40.00
Railway tracks	75.00	100.00	*Not found*		
Sea	94.33	96.38	Sea	84.14	92.42
Average	**88.59**	**82.96**	**Average**	**82.72**	**73.29**

Precision/recall for Venice, Italy: TerraSAR-X *vs.* Sentinel-1A



Diversity of retrieved categories for Venice, Italy: TerraSAR-X (left) *vs.* Sentinel-1A (right)

Conclusion and Outlook

Sentinel-1A data provide a robust classification of natural land cover in coastal areas. Our next topic will be the transferability between Sentinel-1A and TerraSAR-X classifications, as well as temporal changes seen by both instruments. Here we expect quantitative time series results of dynamical processes such as coastline and vegetation changes.

References

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[2] C-TEP project. Available: https://coastal-tep.eo.esa.int/
[3] O. Dumitru, G. Schwarz, and M. Datcu, *SAR Image Land Cover Datasets for Classification Benchmarking*, JSTARS, 2017, under review.
[4] O. Dumitru, S. Cui, D. Faur, and M. Datcu, *Data analytics for rapid mapping: Case study of a flooding event in Germany and the tsunami in Japan using very high resolution SAR images*, JSTARS, vol. 8(1) , pp. 114–129, 2015.
[5] O. Dumitru, G. Schwarz, and M. Datcu, *Land Cover Semantic Annotation Derived from High Resolution SAR Images*, JSTARS, vol. 9(6), pp. 2215-2232, 2016.
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